U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration Atlantic Oceanographic and Meteorological Laboratory
4301 Rickenbacker Causeway Miami FL 33149

Miami, March 2016

Captain of the CMA CGM Racine

Dear Captain:

On behalf of the United States Department of Commerce's Atlantic Oceanographic and Atmospheric Administration, I would like to thank you and your Company for your help and cooperation in providing us with the opportunity to use your ships to deploy oceanographic instrumentation. Mr. Grant Rawson of the Atlantic Oceanographic and Meteorological Laboratory, will perform this cruise.

The Atlantic Oceanographic and Atmospheric Laboratory is located in Miami, Florida, and is one of twelve laboratories of the National Oceanographic and Atmospheric Administration (NOAA). You may be familiar with one of our sister organizations, the U.S. National Weather Service. The Physical Oceanography Division of this laboratory has the mission to investigate the effect of the ocean on climate. To accomplish this we maintain an oceanographic and climate observing system to, for example, measure the upper ocean thermal structure and currents. Several data sets are obtained and developed by our laboratory's staff of scientific and technical support personnel to investigate the ocean processes and their link to climate variability and environmental changes.

In addition to the XBTs, instruments deployed to measure the temperature profile of the ocean, other instruments such as drifters and floats are sometimes also deployed to help investigate ocean currents. Many of the results obtained from our research can be viewed in real or near-real time on our laboratory's web pages at *www.aoml.noaa.gov/phod*. Specific information about this program can be accessed at our projects web page *www.aoml.noaa.gov/phod/soop*. Of special interest to you could be the web pages where we show results obtained from high density deployments done from ships participating in the Ship Of Opportunity Program: *www.aoml.noaa.gov/phod/hdenxbt*. Results obtained from observations and instrument deployments from volunteer ships are transmitted in real-time to our laboratory and then used by the National Weather Service to produce their marine and atmospheric forecast. Shipping companies such as yours then use their information as an aid for their operations.

Please feel free to contact us in case you have any question regarding our activities or results, or if you are further interested in using our ocean currents and wind products. We sincerely appreciate the opportunity you give us to do our research and enhance the current ocean observing system.

Thank you very much for your time, consideration and attention.

Dr. Gustavo Jorge Goni
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National Oceanic and Atmospheric Administration
Atlantic Oceanographic and Meteorological Laboratory - Physical Oceanography Division
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Miami, FL 33149
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March 2016

Cruise Plan – AX07

Ship Name: **CMA CGM Moliere**

Call sign: **9HA2072**

IMO: **9401099**

Project Title: Ship Of Opportunity Program
High Density XBT Transect AX07.

Beginning date: On or about March 18, 2016 from Miami, Fl

Ending date: Arriving April 5, 2016

Loading date: March 18, 2016, Florida, USA

Scientific Ship Rider: Mr. Grant Rawson, NOAA/AOML

Cruise overview

Description of the Scientific Program

The **CMA CGM Moliere** is a vessel with the Atlantic and Oceanographic Meteorological Laboratories' Ship Of Opportunity Program (*www.aoml.noaa.gov/phod/soop*). The SOOP vessels repeat voyages across the same trans-Atlantic routes provides scientist with the opportunity to conduct measurements of the upper ocean thermal structure along the transect called AX07 that falls on 30°N. This latitude is ideal for monitoring heat flux transport variability in the Atlantic in correlation to the subtropical gyre intensity. Our partnership with these vessels allows the study to be conducted every 3 months, to monitor and determine the seasonal-to-inter-annual temperature variability of the upper ocean layer through the use of expendable temperature probes (XBTs) in high resolution. This SOOP transect meets World Ocean Circulation Experiment (WOCE) criterion for high-resolution deployment providing temperature profiles every 50 km in the open ocean and between 10-30 km near boundary currents down to a depth of about 800 m.

The XBT data of this region is used in studies of overall water column surveys, estimates of the Florida Current, eddy structures and Deep Western Boundary Current Transports. These are incorporated into the atmospheric-ocean forecast models and implemented at the National Meteorological Center.

Implementation

Sampling along this section (designated AX07) began in 1994 (Figure 1) and meets the WOCE (World Ocean Circulation Experiment) criterion for high resolution deployment providing temperature profiles every 40 km in the open ocean and between 10-30 km near boundary currents down to a depth of about 800 m.

Sampling on this section should be of consistent horizontal spacing of XBT probes (see below) and a nearly repeating track line for each of the crossing in order to minimize the differences between sections and the possible aliasing of horizontal gradients in temperature into time changes of temperature.

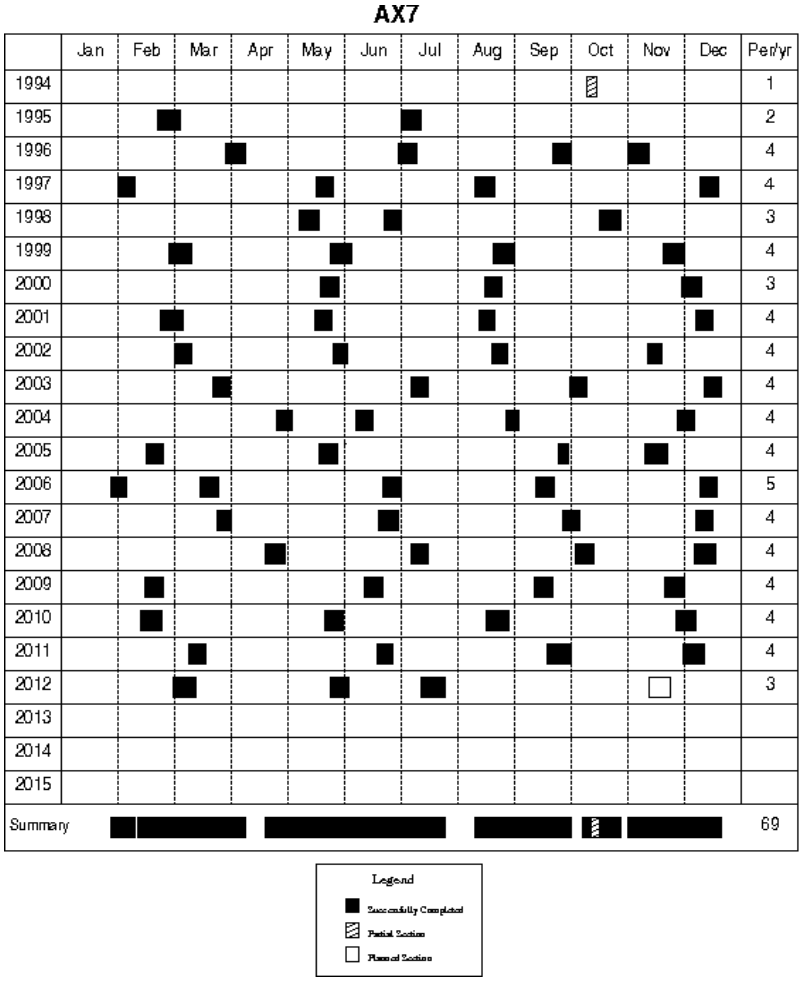

Figure 1*: Table of times of all section occupations since the program began in 1994*

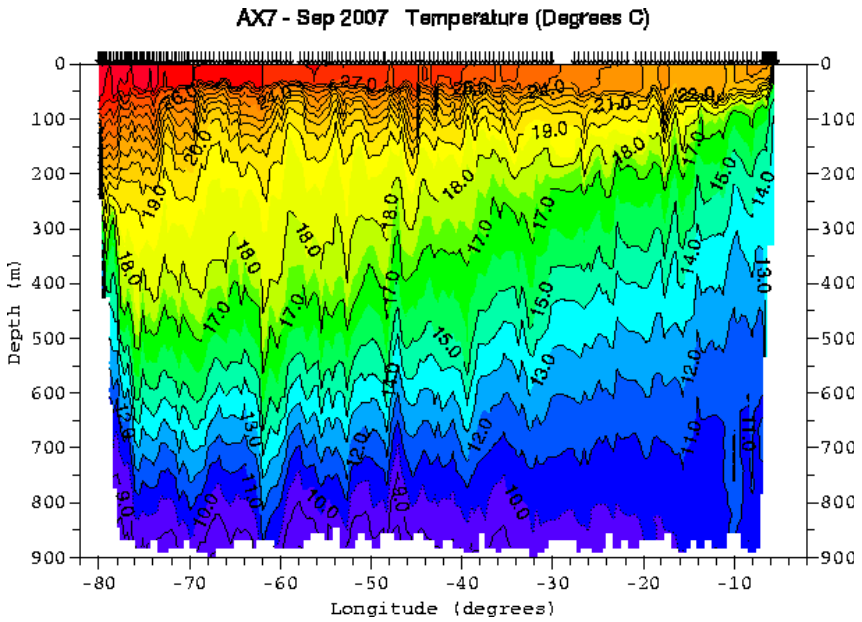

Figure 2. *This figure shows a temperature section of a typical crossing along the AX7 route. Temperature contours shown on the figure are in °C. This section was taken aboard the* ***BARCELONA EXPRESS*** *September of 2007.*

Figure 2 shows a typical temperature section across the subtropical Atlantic. Some features in these sections include:

- Increase depth of isotherms (constant temperature surfaces) towards the west (e.g., 15°C isotherm starts near 100m in the east and deepens to over 650m in the west).
- A rapid decrease in the depth of isotherms near the western boundary (where the Florida Current and Azores current bring warm water northward).
- Warmest surface water is found in the west (near the Gulf Stream/Florida Current and the subtropical gyre recirculation).
- Large fluctuations in the depth of temperature surfaces between 20-30°W where the Azores current crosses the section.

The XBTs deployed will identify the vertical structure of the mesoscale features present in the region.

XBT Deployment Plan

PLEASE NOTE: IT IS THE RESPONSIBILITY OF THE RIDER TO ENTER THE SHIP'S IMO NUMBER AND CALLSIGN INTO THE SEAS METADATA SETUP. This information is included in the first page of this Cruise Plan

A. Deployment plan for vessel routes making "Great Circle" transects: Port Miami to Gibraltar

1. From **Port Miami(200m deep, approximately 80°1' W)** to **79°09'W,27°06'N**:
   - High resolution sampling every 10 km; 18 probes over 175 km.

2. From near **79°09'W**,**27°06'N** to near **75°W, 29°N**:
   - High resolution sampling every 15 km; 30 probes over 450 km.
     Use Table 1. to determine time intervals. (For example at 20 knots deploy every 24 min.)
   - Fast Deep XBTs shall be deployed every 8th drop (drop 7 Deep Blue Probes, then drop a Fast deep on the 8th.) With the first probe as close to 77 degrees west as possible.

3. From near **75°W, 29°N** to **70°W**:
   - Medium sampling every 30 km: 18 probes over 540 km.
     Use Table 1. to determine time intervals. (For example at 20 knots deploy every 49 min.)
   - One deep XBT every 8 XBT probes.

4. From near **70°W 31°30'N** to near **35°W**:
   - Standard sampling every 30 km; 112 probes over 3,340 km.
     Use Table 1. to determine time intervals. (For example at 20 knots deploy every 1hr 21min.)
   - One deep XBT probe every 8 XBT probes.

5. From **35°W** to **15°W**:
   - Medium resolution every 30 km; 60 probes over 1810 km.
     Use Table 1. to determine time intervals. (For example at 20 knots deploy every 49 min.)
   - Continue one deep XBT every 8 XBT probes.

6. From **15°W** to **10° W**:
   - Medium resolution sampling every 30 km; 9 probes over 250 km.
     Use Table 1. to determine time intervals. (For example at 20 knots deploy every 48 min.)
   - One deep XBT every 8 XBT probes (drop 7 Deep Blue Probes, then drop a Fast deep on the 8th)

7. From **10° W** to **200m Depth** (approx **5°44'W)**:
   - High resolution sampling every 15 km; 27 probes over 410 km.
     Discontinue Fast Deeps less than 1000m (approx 8 deg 30' W). (drop 7 Deep Blue Probes, then drop a Fast deep on the 8th)

9. From **5°44'W(Tangier)** to **Valencia, Spain**:
   - Break down and pack all equipment. Rinse auto-launchers in fresh water and dry before packing. Store all equipment for unloading in Port Miami.

B. Plan for routes from Port Miami through the North West Providence Channel

1. Florida Straits:
   High resolution sampling every 12 km, beginning in 100-200m depth (approx 80.02 West),To near Great Isaacs, Bahamas (Near 26-10'N, 79-12'W). Approx 8 probes.

2. From near **Great Isaacs to Hole in the Wall, Abaco (near 25-48'N, 77-07'W)**:
   - Medium resolution sampling every 30 km: 6 probes over 176 km.
     Use Table 1. to determine time intervals. (For example, at 20 knots deploy every 48 min.)

3. From Hole in the Wall to near **26N, 76-20'W**:
   - High resolution sampling every 10 km: 11 probes over 107 km.
     Use Table 1. to determine time intervals. (For example, at 20 knots deploy every 16 min.)

4. From near **76-20'W** to near **70°W**:
   - Medium sampling every 30 km; 21 probes, over 635 km.
     Use Table 1. to determine time intervals. (For example, at 20 knots deploy every 48 min.)

- One Fast Deep XBT probe after every 8 XBT probes.

5. From near **70°W** to near **35°W**:
   - Medium sampling every 30 km; 112 probes over 3,340 km.
     Use Table 1. to determine time intervals. (For example at 20 knots deploy every 1hr 21min.)
   - One Fast Deep XBT probe after every 6 XBT probes.

6. Continue following the Great Circle Sampling (#5., 6., 7., 8., & 9. Above.)

If the ship is traveling at a different speed it will be necessary to adjust the launch times (see Table 1 as a quick guide). If the planned cruise track deviates significantly from the outline above please notify Shenfu Dong at (305)361-4372, email: Shenfu.Dong@noaa.gov.

XBT Drop rate						
Ship Speed (knots)	Desired Sampling Space					
	10 km	**15 km**	**20 km**	**30 km**	**40 km**	**50 km**
10	32 min	48 min	1 h 04 min	1 hr 37 min	2 hr 09 min	2 hr 42 min
11	29 min	43 min	58 min	1 hr 28 min	1 hr 57 min	2 hr 27 min
12	27 min	40 min	54 min	1 hr 21 min	1 hr 47 min	2 hr 15 min
13	25 min	37 min	50 min	1 hr 15 min	1 hr 39 min	2 hr 04 min
14	23 min	34 min	46 min	1 hr 10 min	1 hr 32 min	1 hr 55 min
15	22 min	33 min	44 min	1 hr 05 min	1 hr 26 min	1 hr 48 min
16	20 min	30 min	40 min	1 hr 00 min	1 hr 20 min	1 hr 41 min
17	19 min	29 min	38 min	57 min	1 hr 16 min	1 hr 35 min
18	18 min	27 min	36 min	54 min	1 hr 11 min	1 hr 30 min
19	17 min	25 min	34 min	51 min	1 hr 08 min	1 hr 25 min
20	16 min	24 min	32 min	48 min	1 hr 04 min	1 hr 20 min
21	15 min	22 min	30 min	46 min	1 hr 01 min	1 hr 17 min
22	14 min	21 min	28 min	44 min	58 min	1 hr 13 min
23	13 min	20 min	26 min	42 min	56 min	1 hr 10 min
24	13 min	19 min	25 min	40 min	53 min	1 hr 07 min
25	12 min	18 min	24 min	38 min	51 min	1 hr 04 min

Table 1. *Time interval between XBT launches based on ship speed and desired sampling spacing.*

To convert from Kilometers to nautical miles: NM=Km X 0.539956804
To convert from Nautical Miles to Kilometers: Km = NM x 1.852
For instance: 25 Km = 13.4989 Nm or 30 Km = 16.1987 Nm

If the planned sampling is interrupted for any reason (such as an autolauncher failure) the procedure will be to drop another probe as close as possible to the planned drop and continue with the desired spacing of the XBTs for that section of the cruise track (according to the above guide). If a serious malfunction of the autolauncher occurs then manually deploy the XBTs from the stern of the ship using the hand launcher. While this happens, please be troubleshooting the problems and be in contact with Zach Barton, Ulises Rivero (*Ulises.Rivero@noaa.gov)*, Andy Stefanick (*Andrew.Stefanick@noaa.gov)*, or Pedro Pena (*pedro.pena@noaa.gov*).

The ship-rider will work as needed around the clock to:

1) check and load the auto-launcher;
2) check that the system is logging data correctly;
3) keep a log of problems, repeated casts due to suspected XBT errors and weather conditions;
4) inform NOAA personnel of any difficulties; and,
5) deploy ARGO profiling floats and surface drifting buoys as necessary.

ARGO float deployments

0 Argo deployments will occur.

Drifter deployments

0 Drifting buoys will be deployed during the transit.

Summary

This high resolution XBT transect will require 264 probes plus an anticipated 10% failure rate of 26 probes for each Atlantic crossing. This requires a total of 290 probes per crossing. Drifting buoys and ARGO floats might be deployed during this cruise.

Typical Temperature Profile Examples

Below are examples of typical temperature profiles expected on this transect.

Typical Temperature Profile, Mediterranean Sea	**Typical Temperature Profile, Approaching Straits of Gibraltar from East**
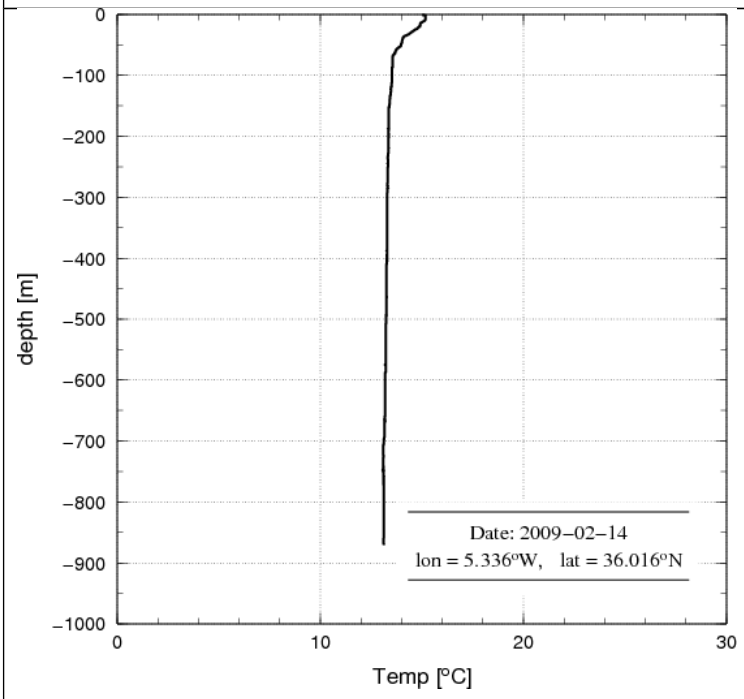	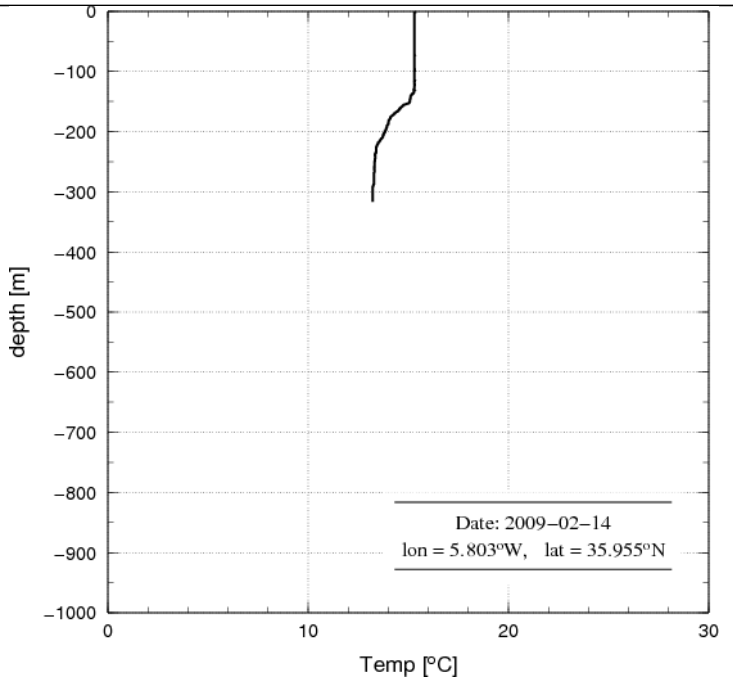
***Figure 5a**. A typical temperature profile inside the Mediterranean Sea. Inside the Sea, the temperature is extremely uniform below the mixed layer and seasonal thermocline (below about 175 m). Values as high as 14.5 C are relatively common. Note the "hit bottom" spike appears near 870 m. Large temperature inversions are not found. These profiles are good to use to check for electrical noise (some very small scale uniform noise shown here)*	*Figure 5b. Approaching the Straights of Gibraltar from the east profiles typically look like this, with no subsurface temperature inversions. Note the "hit bottom" spike at 320 m and no uniform garbage reading below. Smith and Sandwell bathymetry should indicate a water depth of 313 m at this location to help aid the rider, but the abrupt character of the temperature spike and in particulatr the fact that the highest temperature in the spike is not found elsewhere in the profile are good indicators this is not a real feature.*

Typical Temperature Profile, Mediterranean Outflow,Topography Steepening	Typical Temperature Profiles, "Meddy" in deeper water. Return of colder water values below feature
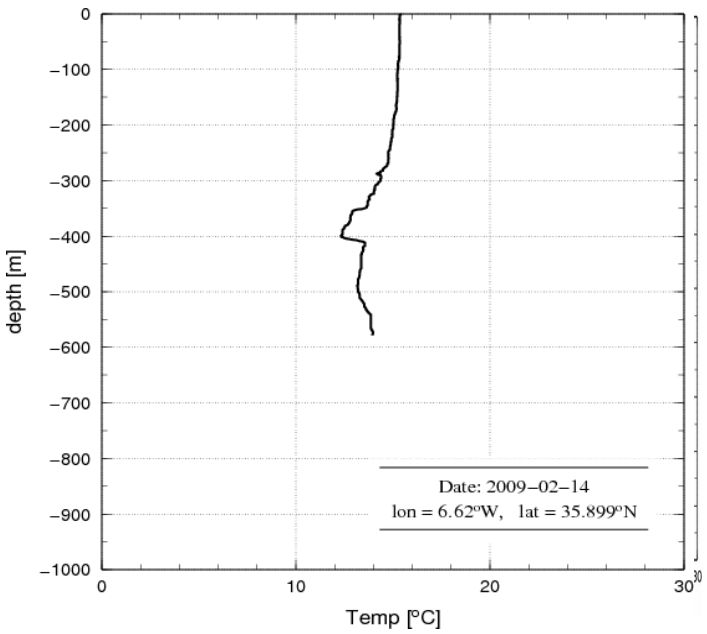	
Figure 5c. *After crossing over a series of sills through the Straits of Gibraltar, as the topography starts to steepen again subsurface temperature inversions below 400 m and above the "hit bottom" spike seen at 580 m. This XBT has captured the warm and salty Mediterranean outflow below 400 m. This warm salty water is in an active start of violent mixing as it slides down the topography here and the double temperature inversion seen here is typical of active mixing, identified as Kelvin-Helmholtz instabilities (relative to a massive underwater breaking wave). Smith and Sandwell topography estimates accurately predict the local bottom depth as identified by the bottom spike.*	***Figures 5d and 5e****. In deeper water some of the very salty Mediterranean water can pinch off, forming Meddies (Mediterranean eddies) at depth, which appear as a temperature inversion below 800 m Note with the deeper XBT probe we can see the temperatures returning to colder values below this feature (something wire stretch would not do).*

Typical Temperature Profile, Atlantic Basin- Example of Subsurface Feature	**Typical Temperature Profile, Gulf Stream**
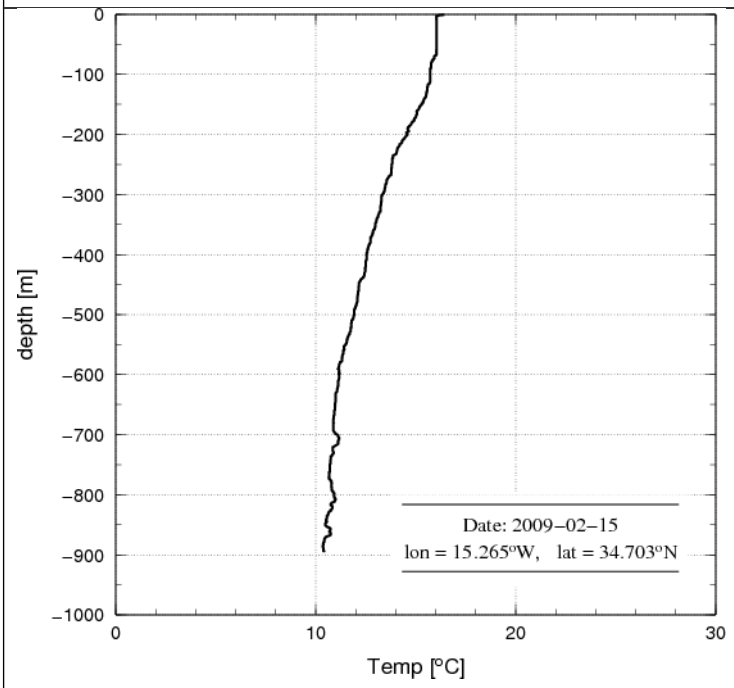	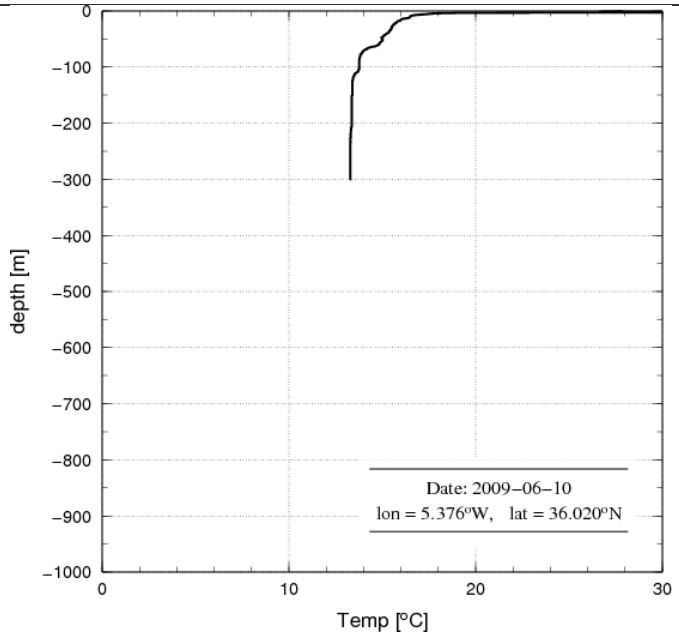
***Figure 5f**. Because of the nearby presence of Mediterranean outflow water, subsurface temperature inversions below 600 m cannot be ruled out as a natural signature (Figure 5f). Temperature profiles will become increasingly warm with depth across the rest of the basin to include nearly uniform subsurface temperature the closer to the Gulf Stream and recirculation the position is.*	***Figure 5g** In the Gulf Stream, profiles will exhibit more overall "jitter" than in the past 30 degrees of transit and could have small (in value and in vertical scale) temperature inversions. Temperature profiles can have a nearly uniform temperature at the bottom and we like to see "hit bottom" spikes to distinguish these from probes sitting on the bottom with uniform temperature readings.*

Basic Ship Visit and Rider Rules *– courtesy of Steve Cook et al*

The following guidelines pertain to any person who might have occasion to visit, install, repair or replace equipment, or ride on any Ship of Opportunity Program (SOOP) ship participating in any program to collect scientific observations. Most of these guidelines are based upon common sense and respect for those who "live" on the vessel. Visitors are essentially being invited into their home as a guest and, as a guest, desire to be invited back. A goal within the SOOP Program has always been to minimize the shipboard impact as much as possible. These are not "Cruise Ships" or "Research Vessels" and therefore ship riders strive for self-sufficiency. There are times, like departing or arriving in port or navigating congested waters that the bridge officers and crew have to concentrate on their own responsibilities and not the rider's. Please leave them alone during this time. It is always a good idea to brief the Captain and Chief Engineer prior to departure as to the plans and scope of the work and exactly what will be needed from the bridge officers or any other assistance.

These guidelines are not just for the novitiate "first timer", but also for those who have often visited or ridden the same ship many times. It is certainly acceptable and beneficial to be knowledgeable about the ship's standard operation but don't become familiar to the point of complacency and forget the basic rules of respect. Ship riders should always remember that they are professionals involved in the collection of important scientific information and they not only represent themselves but also Scripps and the SOOP program.

Following is a list of basic guidelines that should be observed.

- Always see the Captain and/or Chief Officer when first boarding the ship.
- If riding the ship, then learn the ship's daily watch schedule. Know when meal times and coffee breaks are scheduled and plan activities accordingly.
- Be in good health, as this work can be very exhausting and the hours long.
- If alcohol is allowed on board, limit consumption in order to use good judgment in regards to personal interactions and because it may be necessary at any time to go to work
- Be cognizant of ship customs and protocol.
  - For instance, if people wait for the Captain to sit down, then don't sit down before he does.
  - Wait to be invited or ask permission to enter special places like the bridge, engine room or lounge area.
  - If the officers remove their shoes before entering their lounge area or stateroom, then follow the example
- Wear appropriate clothing and shoes. Ragged shorts, bathing suits or sandals are inappropriate.
- Don't sleep in a public space or prop feet up on any table or desk and "kick back".
- **Don't bring food out on deck, especially in port, and especially in Australia. Instant $1000 fine!**
- If it is necessary to conduct a meeting in a stateroom leave the door open.
- Clean up messes and keep gear stowed away when not in use. Work areas should be kept tidy so ship's personnel don't have to "step over" the equipment or supplies to conduct their own jobs.
- When there is a lot of activity on the bridge, limit questions and conversations. A detailed briefing of what is required from the bridge officers conducted prior to departure should minimize confusion and stress.
- Bring all necessary tools. Don't ask to borrow ship's tools if possible.
- Use email or telephone whenever possible to keep the ship and agents apprised of schedule and plans.

Some of the participating SOOP support several different scientific projects and, as such, the combined impacts of those projects become cumulative and can increase the stress on the officers and crews. It is essential that all projects coordinate their ship support activities so they don't overburden the system and are asked to leave the ship entirely. There are real-time operational requirements that contribute to safety at sea issues and there are special scientific projects that support science. Both can be accommodated but it is incumbent on those who meet and greet these ships to take the time and effort to accommodate the basic needs of the mariners who contribute so much to the program's success.

High Density Check-in list for the Ship Rider

Date Completed

The ship rider is the primary person responsible for ensuring the success of the cruise. This includes checking that all the necessary equipment has been tested and loaded in the ship, verifying weather conditions, ship schedules, possible ship delays etc. Before traveling the rider must have all documents and contact information required for the cruise.

Equipment testing: _____

- Verify that all equipment to be sent from AOML has been thoroughly tested before shipping.
- Comment if not testing was performed:

  _____

  _____

  _____

Check equipment shipping and loading: _____

- Contact Robert Roddy (*Robert.J.Roddy@noaa.gov, 305 361-4434)*, and/or Zach Barton (*Zach.Barton@noaa.gov, 305-361-4548)* to confirm the status of equipment shipment and loading.

Check ship route _____

- Contact Robert Roddy (*Robert.J.Roddy@noaa.gov, 305 361-4434)*, and/or Zach Barton (*Zach.Barton@noaa.gov, 305-361-4548)* to confirm that the ship is on the scheduled route two days in advance of the cruise's planned date as well as the day before of your travel. Also communicate with Robert and Zach to inform them of your travel arrangements for the cruise.

Contact support at AOML _____

- Contact Robert Roddy and Zach Barton at least two days in advance of the cruise's planned date to coordinate ship access, share itineraries, etc.

Record height of deployments: _____

- Please take note of and put in your report the approximate height that the deployments were made from. (Top of the water to where the probe was launched from.)

Useful information:

To personally confirm the date and time for the ship being in port, use the Port Miami Daily dock report at: https://seaport2.miamidade.gov/dailydock/Default.aspx

Check the dates and look for the ship that you will be on. The times on the site are approximate. Robert Roddy or Zach Barton can contact the agent that has more up to date times and information.

High Density Check-out list for the Ship Rider

Date Completed

Data submission to AOML after the cruise _____

The following files should be sent to AOML after the cruise, regardless of data transmissions during the cruise:

1. All XBT data in .BIN, and electronic XBT drop log sheet.
2. There is a compress data button in Amverseas that will compress everything you need and open the location in a file browser. Please ensure that this zipped folder is sent to AOML. The important files should this not work are: HistoryProfiles.txt – found at: c:\users\public\public documents\AMVERSEAS\XBT\ARCHIVE
3. Cruise summary for the web page
4. Cruise Report
5. Drifting buoy log sheet and ARGO float log sheet in case of deployments of these instruments

The data can be submitted in a CD, memory stick or in a zip file as an email attachment.

Sent the XBT data and HistoryAllAttempts.txt to each of the following:

Robert Roddy	*Robert.J.Roddy@noaa.gov*	_____
Yeun-Ho Daneshzadeh	*Yeun-Ho.Chong@noaa.gov*	_____
Francis Bringas	*Francis.Bringas@noaa.gov*	_____
Zach Barton	*Zach.Barton@noaa.gov*	_____

Argo deployment information while underway:

e-mailed to: *aoml.argo@noaa.gov* and *deploymentinfo@whoi.edu* _____

Drifting buoy deployment information while underway:

Shaun Dolk	*Shaun.Dolk@noaa.gov*	_____

Cruise summary for the webpage. This information goes on the webpage and includes the number of XBTs deployed, drifters/floats deployed, any data affecting issues, etc. Send an email to each of the following with your summary:

Gustavo Goni	*Gustavo.Goni@noaa.gov*	_____
Shenfu Dong	*Shenfu.Dong@noaa.gov*	_____
Yeun-Ho Daneshzadeh	*Yeun-Ho.Chong@noaa.gov*	_____
Francis Bringas	*Francis.Bringas@noaa.gov*	_____

Please email a Cruise Report to Shenfu Dong, Gustavo Goni, Zach Barton, Robert Roddy, and Francis Bringas stating the following:

XBTs deployed
Drifters deployed (ID, date, time, latitude, longitude)
Profiling floats deployed (start time, deployment time, latitude, longitude)
GTS transmission (Real-time, twice a day, problems)
Additional equipment, tools, supplies needed
Problems
Recommendations
Other narrative